

What is Claimed:

1               1. An ultrafast nonlinear all-optical switch having a switching  
2 speed of less than 1 picosecond for light with a wavelength of about 1.55  
3 micrometers, the switch comprising:

4               (a) a substrate; and

5               (b) a material disposed on the substrate, the material including a  
6 plurality of carbon nanotubes and a polymer forming a composite.

1               2. The material according to claim 1 wherein the material is a  
2 third-order nonlinear optical material.

1               3. The material according to claim 1 wherein the material is  
2 substantially transparent.

1               4. The material according to claim 1 wherein the polymer is  
2 polyimide.

1               5. The material according to claim 1 wherein the nanotube  
2 loading is less than about 0.1 wt %.

1               6. A nonlinear optical material comprising a plurality of  
2 carbon nanotubes and a polymer forming a composite.

1               7. The material according to claim 6 wherein the material is a  
2 third-order nonlinear optical material.

1               8. The material according to claim 6 wherein the material is  
2 substantially transparent.

1               9. The material according to claim 6 wherein the polymer is  
2 polyimide.

- 1                   10. A nonlinear optical article comprising:
- 2                   (a) a substrate; and
- 3                   (b) the material of claim 6 disposed on the substrate.
- 1                   11. The nonlinear optical article according to claim 10 wherein  
2                   the article is an ultrafast all-optical switch.
- 1                   12. The ultrafast all-optical switch according to claim 11  
2                   wherein the switch has a switching speed of less than 1 picosecond for light with  
3                   a wavelength of about 1.55 micrometers.
- 1                   13. A process for preparing a nonlinear optical switch  
2                   comprising:
- 3                   (a) preparing a plurality of carbon nanotubes;
- 4                   (b) suspending the nanotubes in a solvent;
- 5                   (c) sonicating the nanotube-and-solvent suspension, yielding a  
6                   suspension with substantially uniformly distributed nanotubes;
- 7                   (d) separately dissolving a polymer resin in the solvent, yielding  
8                   a polymer solution;
- 9                   (e) mixing the nanotube-and-solvent suspension and the polymer  
10                  solution, yielding a uniform distribution of nanotubes in polymer solution;
- 11                  (f) baking the nanotube-polymer solution to remove most of the  
12                  solvent;
- 13                  (g) curing the polymer resin;

14                             (h)     baking the nanotube-polymer composite to remove any  
15     retained solvent and to form a nonlinear optical nanotube-polymer composite  
16     material; and

17                             (i)     depositing the material on a substrate.

1                             14.    The process according to claim 13 wherein the step of  
2     depositing the material on the substrate is accomplished using lithography  
3     techniques.

1                             15.    The process according to claim 13 wherein the carbon  
2     nanotubes are purified before they are suspended in the solvent.

1                             16.    The process according to claim 13 wherein the concentration  
2     of the carbon nanotubes is tuned to achieve predetermined properties in the  
3     material.

1                             17.    The process according to claim 13 wherein the polymer is  
2     polyimide.

1                             18.    The process according to claim 13 wherein the step of  
2     preparing the nanotubes includes applying the HiPCO method.

1                             19.    The process according to claim 13 wherein the solvent is  $\gamma$ -  
2     butyrolacetone.

1                             20.    An ultrafast all-optical nonlinear switch comprising:

2                             (a)     a substrate; and

3                             (b)     a material disposed on the substrate, the material including a  
4     plurality of carbon nanotubes incorporated into a silica.